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INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH  
TECHNOLOGYSTUDY ON TECHNOLOGICAL PEDAGOGY CONTENT KNOWLEDGE  
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## ABSTRACT

In order for teachers to carry out learning optimally, teachers need to have knowledge of content, pedagogy, and technology. This third slice of knowledge is called technology pedagogic content knowledge (TPCK). The purpose of this study is to describe the TPCK of mathematics teachers. This type of research is qualitative. The research subjects were all mathematics teachers at SMA Negeri 2 Singaraja. The instruments used to measure TPCK are questionnaires and interviews. Methods of collecting data using a questionnaire, and interview guidelines. Data related to TPCK were analyzed descriptively. This study shows that technological knowledge (TK), content knowledge (CK), pedagogic knowledge (PK), technology content knowledge (TCK), technology pedagogical knowledge (TPK), pedagogical content knowledge (PCK), technology pedagogical content knowledge (TPCK) the mathematics teachers are classified as good. However, judging from the tenure, junior teachers have very good TK, TCK, and TPK, while CK, PK, PCK, and TPCK are good.

**Keywords:** content knowledge, pedagogic knowledge, technological knowledge, technology pedagogic content knowledge.

## 1. INTRODUCTION

State High School (SMA) 2 Singaraja is located at Jl Srikandi Singaraja, Kec. Buleleng, Kab. Buleleng. This school has a vision of Smart, Excellent, Cultured, Based on the Tri Hita Karana Concept. There are similarities with Undiksha's vision, which is both based on Tri Hita Karana. The interest of the school community at SMA Negeri 2 Singaraja is quite high. Every year the school accepts 10 new classes of students. The results of an interview with a mathematics teacher, there are 7 teachers who teach mathematics, consisting of 4 teachers with experience above 20 years, and 3 teachers with experience under 3 years.

The teacher is an important component in learning. Learning is a process of interaction between teachers, students, and learning resources in the learning environment. In accordance with this understanding, student achievement is influenced by student behavior, and student behavior is influenced by teacher behavior and student characteristics, as well as attitudes towards mathematics. The teacher's own behavior is influenced by the characteristics of the teacher, the teacher's knowledge (material, pedagogy, student learning), the teacher's attitude, the teacher's belief in students, the teacher's belief in learning and mathematics, student characteristics, and student behavior.

Learning mathematics in the classroom is not intended only to transfer teacher knowledge to students, but so that students can understand what they are learning. Students learn with understanding when teachers teach with understanding. Students will remember and be able to apply the concepts learned when students understand these concepts. Learning with understanding is only possible if the teacher has good Content Knowledge (CK) and Pedagogical Knowledge (PK). Content Knowledge (CK) is the teacher's knowledge about the material and PK is the teacher's knowledge about learning and how students learn mathematics.

Advances in digital technology have implications for various aspects of human life, including in the field of education. requires teachers to have technological literacy, both related to the use of digital technology-based



learning resources, digital technology-based learning, as well as the development of materials that integrate digital technology. The existence of the Covid-19 pandemic requires teachers to understand several platforms that are used as tools or means in implementing online learning. Therefore, in order for teachers to carry out mathematics learning well, teachers need to have competencies related to Technology Knowledge (TK), CK, and PK. This third slice of knowledge is known as Technology Pedagogical Content Knowledge (TPCK). Therefore, it can be understood that TPCK will be closely related to the intersection between TK and CK, TK and PK, and CK and PK.

Turnuklu and Sibel Yesildere (2007) conducted research on elementary school teachers in Turkey found that there is a link between CK and Pedagogical Content Knowledge (PCK), and PK and PCK are two types of knowledge that are important in learning mathematics. Murat Peker (2016) found that CK and PCK have a high relationship to effective learning.

Lisa Etheridge (2016) found that mathematics anxiety and mathematics self-efficacy were predictors of teacher self-efficacy in learning mathematics. Gulistan, M; Muhammad Athar Hussain and Muhammad Mushtaq.(2017) found that there was a very strong relationship between teacher self-efficacy and secondary level students' mathematics learning achievement. Liu, X and Koirala (2009) found that there is a strong relationship between self-efficacy and student achievement.

TPCK is a slice of technological, pedagogical, and content knowledge. as shown in the following figure.

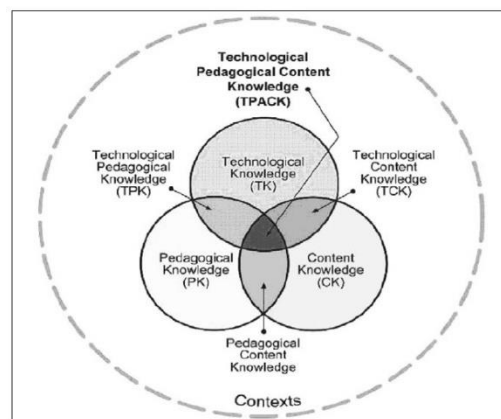


Figure 01. TPCK (Denise, at all ,2009)

- Technological knowledge (TK), refers to knowledge of various technologies, from low-tech technologies such as pencil and paper to digital technologies such as the Internet, platforms, video, interactive whiteboards, and software programs.
- Content knowledge (CK), is knowledge about the actual subject matter that must be learned or taught (Mishra & Koehler, 2006). Teachers should know about the content they will teach and how the nature of knowledge differs for different content.
- Pedagogical knowledge (PK), refers to teaching methods and processes and includes knowledge in classroom management, assessment, lesson plans development, and student learning.
- Pedagogical content knowledge (PCK), refers to content knowledge related to the teaching process (Shulman, 1986). Pedagogical content knowledge differs for different content areas, as it blends content and pedagogy with the aim of developing better teaching practices in content areas.
- Technological content knowledge (TCK), refers to knowledge of how technology can create new representations for certain content. This suggests that teachers understand that, by using certain technologies, they can change the way students practice and understand concepts in certain content areas.
- Technology pedagogical knowledge (TPK), refers to knowledge of how various technologies can be used in teaching, and to understanding that using technology can change the way teachers teach.
- Technology pedagogical content knowledge (TPCK), refers to the knowledge required by teachers to integrate technology into their teaching in any content area. Intuitively, teachers have an understanding

of the complex interactions between the three basic components of knowledge (CK, PK, TK) by teaching content using appropriate pedagogical methods and technologies.

According to the description above, it is very interesting and important to conduct an assessment related to the Technology Pedagogical Content Knowledge (TPCK) for Mathematics teachers.

## 2. METHOD

This type of research is qualitative. The research subjects were all mathematics teachers at SMA Negeri 2 Singaraja. The instruments used to measure TK, CK, PK, PCK, TCK, TPK, and TPCK development in mathematics learning are questionnaires and interviews. The questionnaire used to measure TK, CK, PK, PCK, TCK, TPK, and TPCK adopted the questionnaire developed by Denise, *et al.*, (2009). Methods of data collection using a questionnaire, and interview guidelines. The research procedure is as follows.

- Determine the research subject, namely all mathematics teachers at SMA N 2 Singaraja
- Describe the profile of the research subject, especially with regard to employment status, and teaching experience.
- Collect data on TK, CK, PK, PCK, TCK, TPK, and TPCK with questionnaires
- Perform descriptive data analysis
- conducted interviews with several teachers, namely teachers who showed responses to “interesting” questionnaires to be developed (based on experience, educational qualifications, or gender), very well or vice versa.

Data relating to TK, CK, PK, PCK, TCK, TPK, and TPCK were analyzed descriptively and classified into very good, good, enough, not good, and very not good, as follows.

**Table 01: Classification of TK, CK, PK, PCK, TCK, TPK, and TPCK**

Score (%)	Classification
84 - 100	Very good
70 – 83	Good
55 – 69	Enough
42 – 54	Not good
≤ 41	Very not Good

Data related to character integration in learning were analyzed descriptively-qualitatively.

## 3. RESULTS AND DISCUSSION

### 3.1 Research Results

As previously described, data on TK, CK, PK, PCK, TCK, TPK, and TPCK were collected using a questionnaire using a Likert pattern with 5 (five) gradations from strongly disagree to strongly agree. The research subjects were 7 people, so the average maximum score of each TK, CK, PK, PCK, TCK, TPK, and TPCK was 35. In detail the results of the study are shown in the following table.

**Table 02. TPCK Teacher**

No.	Aspek	Rata-rata skor	Rata-rata skor (%)	Klasifikasi
1	Technological Knowledge (TK)	28,00	80,00	Good
2	Content Knowledge (CK)	29,00	82,86	Good
3	Pedagogical Knowledge (PK)	28,57	81,63	Good
4	Pedagogical Content Knowledge (PCK)	27,00	77,14	Good

5	Technological content knowledge (TCK)	29,00	82,86	Good
6	Technological pedagogical knowledge (TPK)	27,43	78,37	Good
7	Technological pedagogical Content knowledge (TPCK)	26,00	74,29	Good

Based on the data above, the TK, CK, PK, TCK, TPK, PCK, TPCK teachers are classified as good.

Judging from the teaching experience, namely teachers who have worked for less than 3 years (there are 3 people) and more than 20 years (there are 4 people), the TPCK for teachers is as follows.

*Table 03. TPCK Teachers with less than 3 years of teaching experience*

No.	Aspek	Rata-rata skor	Rata-rata skor (%)	Klasifikasi
1	Technological Knowledge (TK)	13,00	86,87	Very good Baik
2	Content Knowledge (CK)	12,33	82,20	Good
3	Pedagogical Knowledge (PK)	12,42	82,80	Good
4	Pedagogical Content Knowledge (PCK)	11,00	73,33	Good
5	Technological content knowledge (TCK)	13,00	86,87	Very good
6	Technological pedagogical knowledge (TPK)	12,80	85,33	Very good
7	Technological pedagogical Content knowledge (TPCK)	11,75	78,33	Good

Based on the table above, TK, TCK, and TPK teachers with teaching experience of less than 3 years are classified as very good, while CK, PK, PCK, and TPCK are classified as good.

*Table 04. TPCK Teachers with more than 20 years of teaching experience*

No.	Aspek	Rata-rata skor	Rata-rata skor (%)	Klasifikasi
1	Technological Knowledge (TK)	15,00	75,00	Good
2	Content Knowledge (CK)	16,67	83,35	Good
3	Pedagogical Knowledge (PK)	16,00	80,00	Good
4	Pedagogical Content Knowledge (PCK)	16,00	80,00	Good
5	Technological content knowledge (TCK)	16,00	80,00	Good
6	Technological pedagogical knowledge (TPK)	14,20	71,00	Good
7	Technological pedagogical Content knowledge (TPCK)	14,00	70,00	Good

Based on the data in Table 3.4, TK, CK, PK, TCK, TPK, PCK, TPCK teachers with teaching experience of more than 20 years are classified as good.

#### 4. DISCUSSION

State High School (SMA) 2 Singaraja is located at Jl Srikandi Singaraja, Kec. Buleleng, Kab. Buleleng. This school has a vision of Smart, Excellent, Cultured, Based on the Tri Hita Karana Concept. There are similarities with Undiksha's vision, which is both based on Tri Hita Karana. The interest of the school community at SMA



Negeri 2 Singaraja is quite high. There are 7 mathematics teachers, consisting of 4 teachers with over 20 years of experience (senior teachers), and 3 teachers with less than 3 years of experience (junior teachers).

In line with the development of digital technology, effective learning if the teachers have TK, CK, PK, TCK, TPK, PCK, TPCK well. According to the description above, the results of this study in general, show that the TK, CK, PK, TCK, TPK, PCK, TPCK math teachers are all good. These results indicate that the teachers have good content knowledge, and good pedagogy, as well as technological knowledge. In accordance with technological advances and demands due to online learning, all teachers seek to improve their knowledge in order to carry out learning better. Knowledge improvement is carried out through training carried out by the school and sharing information with fellow teachers.

Judging from the tenure, junior teachers have very good TK, TCK, and TPK, while CK, PK, PCK, and TPCK are quite good. This shows that junior teachers are more literate towards technological developments. Although their knowledge of technology is very good, their TPCK is only good which means that they are not very good in teaching certain content using appropriate pedagogic methods and technology. In learning certain materials, the first thing to think about is understanding the content, then how the delivery method (pedagogy) is so that students understand, and what technology is used. The technology used can be an application, platform, video, e-book, or other. This is reinforced by the opinion of the junior teacher as follows.

*JT1 : Materials, pedagogics, and technology that will be used to teach must be related and prepared well before teaching. The technology used must help the learning process, not complicate students' understanding of the material. For example, providing learning videos to help students understand the material and can be watched again if students do not understand.*

*JT2: As teachers we must understand the material being taught and involve technology to make it easier for students to imagine how to be able to manage the class well through the application of technology*

*JT3: I will always think how to convey a material that will be taught can be conveyed well through a method that is in accordance with the characteristics of the material and if it can be supported with the help of technology so that children are more interested in learning.*

On the other hand, CK, PK, PCK, and TPCK for senior and junior teachers are good, in other words, they are relatively the same. This is reinforced by the following statement.

R: What do you do, if there are students who don't understand the material being taught

*ST1: When there are students who do not understand, give an initial question that is easier and relevant to the material given until he understands, after that just give an explanation related to the material given, accompanied by examples, after that give some questions to work on and the results are collected.*

*ST2: I will approach him personally to find out what makes students not understand the material given*

Note : R = researcher, ST = senior teacher, JT = junior teacher

The results of this study support the findings of Patricia F. Campbell, *at all.* (2014); Turmuklu Sibel Yesildere (2007) related to the relationship between CK and PCK knowledge for middle school teachers, it was found that there was a very strong relationship with student achievement. In addition, according to the findings of Murat Peker (2016) that CK and PCK have a high relationship to effective learning.

## 5. CONCLUSIONS

Based on the description above, it can be concluded that in general, TK, CK, PK, TCK, TPK, PCK, TPCK teachers at SMA Negeri 2 Singaraja are classified as good. Judging from the tenure, junior teachers (teaching experience less than 3 years) have very good TK, TCK, and TPK, and CK, PK, PCK, and TPCK are good, while senior teachers (teaching experience more than 20 years) have TK, CK, PK, TCK, TPK, PCK, TPCK are good. Improved ability in technology, pedagogics, and content is carried out through trainings or various (discussions) among teachers. Junior teachers tend to understand technology knowledge better and can integrate very well with content or pedagogy.

Starting from the conclusions above, it is recommended that mathematics teachers continue to develop themselves to increase knowledge of technology, content, and pedagogics and integrate these knowledges so that they can carry out mathematics learning optimally.

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